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SPORTS TRAINING AND TESTING METHODS, APPARATUS AND SYSTEM

Field of the Invention

This invention relates to sports training and testing methods, apparatus and system.

This invention has particular but not exclusive application to a sports training and testing methods, apparatus and system applicable to a wide range of sports including all football codes, athletics, snow and ice sports, tennis, hockey and any other sport where strength, fitness and/or agility are important. For illustrative purposes reference will be made to such applications. However, it is to be understood that this invention could be used in other applications, such as the training and testing of animals.

Discussion of Prior Art

The preparation of athletes (human, equine or otherwise) involves a varying combination of optimising performance in a number of areas, such as follows:

1) Locomotive abilities including speed, acceleration, agility (the ability to change direction), endurance, speed endurance, power, balance and coordination.
2) Decision making ability – the ability to make strategic decisions based on internal and external stimuli and occurrences.
3) Motor processing – including aspects such as reaction time – the combination of collecting and processing internal or external information, formulation a decision, and effecting this decision by changing or maintaining the current activity.
4) Tactical ability and strategy – formulating the best combination of behaviours or movement in order to achieve a desired result. This aspect can be either pre-meditated or formulated in response to internal/external stimuli.
5) Ability to perform to capacity – including freedom from injury or fatigue which may negatively affect performance.

Maximising capability in these areas requires learning, practice and adjustment, until such a time that the desired performance is reached. There are a wide variety of interventions in the sporting world aimed at improving these factors, most of which work on the cyclical system of providing a stimulus or command, which in turn calls for a performance of movement, which has a result or outcome, which provides a feedback mechanism or result to the athlete.

One such example is disclosed in international application WO 88/05323 entitled "Athletic Evaluation and Training Apparatus". The document discloses an apparatus and method for testing and enhancing the ability an athlete to quickly respond to visual stimuli. As the athlete leaves the starting position, two timers are activated. Upon the athlete's arrival at a first way point, the first counter is stopped. Once at the first way point the athlete is then provided with a visual cue, which instructs the athlete to perform a predetermined movement or exercise. On completion of the movement or exercise the second timer is stopped, allowing the total time it took the athlete to complete the entire scenario to be calculated.

Another example is discussed in US Patent No. 6072751 entitled "Athletic Training Device and Method". The document discloses an athletic training device, which includes a control unit coupled at least one finish line unit via a communication link. The control unit provides signals, which simulates a start of race condition. The system may further include intermediate units to measure split time for an athlete. The main control unit then utilises gather timing information from the intermediate and finish line units to determine reaction times of the athlete. The system also records weather and/or atmospheric conditions in addition to the timing information.

US Patent No. 6013007 entitled "Athlete's GPS Based Performance Monitor" discloses a GPS based athletic performance device with real-time feedback. The feedback information is provided to the athlete during the activity through a set of headphones. The device is capable of being coupled to a PC allowing for download and post processing of the feedback information. The process information is then transferred to a web site, which provides the athlete with a comparison of their performance with other athletes using the system.

Much of the prior arts' applications of technology to sport focus on providing retrospective feedback to both the athlete and coach. That is, the majority of such

devices are used as testing tools, rather than actually providing a training stimulus. The sport and exercise environments are becoming increasingly populated with electronic devices for measuring physical performance and biological responses to various types of physical performance tasks. While these devices are able to provide feedback information on various aspects of physical, tactical, and skill based performances, they do not provide direct stimuli for improving training efficacy. As such, these disparate devices do not stimulate the cognitive or tactical aspects of athletic performance such as decision making, reaction time, peripheral vision or environmental awareness that are crucial in the sporting context.

At present, many aspects of sports training and testing are performed manually with considerable subjective elements and potential for bias due to human error. Of the automated fitness test protocols that exist, most of these must be performed in a controlled laboratory environment due to the expense, size and complexity of the equipment involved. These tests, furthermore, are generic in nature and often not specific to the demands of the sport for which they are used.

It would be advantageous to have a system that performs the full process of providing a training stimulus, measuring the outcome/performance, and reporting the outcome to the athlete or trainer in real time.

Summary of the Invention

This invention in one aspect resides in a sports training and testing method for at least one athlete, said method including the steps of:

initiating a predetermined protocol within a control unit;

instructing a plurality of remote units to produce a series of stimuli for said at least one athlete in accordance with the protocol;

receiving feedback information from at least one sensor associated with said at least one athlete's response to the stimuli; and

transmitting the information to said control unit.

In another aspect, this invention resides in a sports training and testing apparatus for at least one athlete, said apparatus including:

a control unit adapted to implement a predetermined protocol;

a plurality of remote units for providing a series of stimuli for said at least one athlete in accordance with the protocol, and

at least one sensor for providing feedback information associated with said at least one athlete's response to the stimuli to said control unit.

Preferably, the control unit and the plurality of remote units communicate with one another via a communications or on-field network.

In a further aspect, this invention resides in a sports training and testing system for at least one athlete, said system including:

an on-field network including:

- a control unit adapted to implement a predetermined protocol for training and/or testing;
- a plurality of remote units for providing a series of stimuli to said at least one athlete in accordance with the protocol;
- at least one sensor for providing feedback information associated with said at least one athlete's response to the stimuli to said control unit, and

a communications link coupling the on-field network to an off-field network, the off-field network including:

- a terminal for receiving from said control unit via the communications link the feedback data for post processing; and
- a memory for storing the post processed data.

In a still further aspect, this invention resides in a sports training and testing method including the steps of:

initiating a predetermined protocol for training and testing within a control unit;

instructing a plurality of remote units to produce a series of stimuli in response to the protocol;

receiving feedback information from at least one sensor in response to the stimuli;

transmitting the information across a communications link to a remote terminal;

processing the received information within the terminal; and

storing the processed information.

Preferably the processed information is stored in a database for display and/or further analysis, as desired.

The predetermined protocol may include one or more pre-programmed or user defined stimuli activation patterns for a series of physical activities in a training regime. Each protocol suitably includes information about location of the remote terminals, the sequencing of the series of stimuli and the required action or response.

A reactive sprinting and agility protocol may include measurement of start reaction time and sprinting time over a random course. A reactive offensive/defensive training protocol may include instructing an offensive player over a random course through a plurality of defensive player that are required to react to the offensive players accordingly without knowledge of said random course. A group reactive training protocol wherein a group of players must complete a series tactical patterns or combinations of play over a random course, may include instructing a first player to move to a randomly selected gate and allowing the remaining players in the group to initiate the most appropriate tactical move or pattern of play in response to the first players movement.

In a further grid training protocol, a small group of athletes (e.g. 3) may be directed through a course provided by a grid type configuration of a number of stations either simultaneously or separately by stimuli specific to the respective athletes, for example 3 coloured lamps at each station in the grid. In a variation of the grid type protocol several small groups of athletes are directed through grid of stations and are further prompted to pass a ball, or other object amongst each other.

Preferably, the control unit is a computer, a portable computer, a personal digital assistant (PDA), palm top, mobile phone or other such suitably portable processing device.

Suitably the remote units receive instructions for producing the stimuli from the control unit either wirelessly or via a fixed connection. Each remote unit may include means for identifying each participating athlete, such as by use of an ID tag.

The stimuli may be audio, visual or a combination thereof. Preferably, the stimuli are mounted on the remote unit but may also be mounted separately to the remote unit. Optionally the remote units may include a data capture sub-unit having a memory. The remote unit may then receive feedback information from the sensors before forwarding the information to the control unit. The remote unit may act as an intermediate hop.

In one form the at least one sensor may be integral with or coupled to the remote unit. Alternatively the at least one sensor may be worn by the athlete. Preferably, the sensor is a biometric sensor, but the system may also utilise other sensor devices such as timers, pressure sensors, pedometers, accelerometer or the like.

The communication link may be a wireless link such as a Radio Frequency (RF), GSM, CDMA, GPRS, Microwave, laser, Infra Red (IR), IEEE 802.11(Wireless Ethernet), Bluetooth™ or other such suitable wireless communication schemes. Alternatively, the communications link may be a wired connection such as RS232, USB, LAN, WAN, Internet, Plain Switch Telephone Network (PSTN), Plain Old Telephone System (POTS), Integrated Services Digital Network (ISDN) or the like.

Preferably, the remote terminal is a workstation running suitable software for processing the protocol feedback data. The workstation may optionally include an internet connection, suitably provided through an associated web server. Furthermore, the workstation may also include a protocol development suite allowing a trainer to tailor a protocol to an athlete's specific training needs.

The processed information is preferably stored in a database allowing a trainer access to historical information about an athlete's progress and to adapt the training regime accordingly. Optionally the trainer may receive intermediate reports regarding the athlete's performance during the training session, allowing the trainer to modify the regime in real time if necessary.

The term "athlete" as used herein, and similar terms including "player" or "competitor", is merely meant to denote a user of the training apparatus or subject

of the training method of the invention. It will be appreciated that whilst a preferred embodiment of invention is described in relation to human athletic type events, it may also find application in sports and training activities of many kinds which may involve interactions with play objects, equipment, animals or machines, such as in the nature of football, snow skiing, horse riding and motor-racing.

Brief Details of the Drawings

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein:

FIG. 1 is a schematic representation of a system according to one embodiment of the invention as described;

FIG. 2 illustrates a control unit and remote units of the on-field network of the embodiment;

FIG. 3 illustrates an example of a reactive sprint/agility protocol;

FIG. 4 illustrates an example of a five-point reactive agility protocol;

FIG. 5 illustrates an example of a reactive offensive/defensive protocol;

FIG. 6 illustrates an example of a four player reactive tactical protocol;

FIG. 7 illustrates an example of a pacing 400m-sprint protocol;

FIG. 8 illustrates an example of a cycling individual pursuit race protocol;

FIG. 9 illustrates an example of a multi-zone timing/pacing protocol;

FIG. 10 illustrates an example of a grid training/testing protocol for individual athletes; and

FIG. 11 illustrates an example of a grid protocol for providing a competitive multiple team game simulation task in Australian Rules football.

A diagrammatic representation of a preferred embodiment of a sports training and testing system in accordance with the invention is shown in FIG. 1. The preferred training and testing system of the invention has two major components, being an on-field network (10) and an off-field network (30). The two networks are coupled by communication link (20) that enables transfer of data and information there between.

As shown in FIG. 1, the on-field network includes at least two main components, being remote units (12) and a control unit (11). Various add-in components (14a and 14b) may be also utilised to enhance the capabilities of the on-field network.

The remote units (12) can be placed in a wide variety of configurations limited only by the range of the radio frequency system used. In one embodiment of the system of the invention, this range is at least 200 metres line-of sight. Furthermore, each remote unit can function as a relay/routing device, thus greatly extending the overall range of the system. Practically such a system would have an unlimited range, provided a distance of no larger than the available transmission range separated any two of the remote units. Each data unit is powered with a removable rechargeable battery, and can be replaced with commercial non-rechargeable cells in that event of the rechargeable cells failing. Alternatively, the units could be powered using solar cells, or another form of radiant energy such as microwave.

A more detailed view of a remote unit (12) is included in FIG. 2. The unit includes at least two components, being a data capture sub-unit (12a) and a reactive sub-unit (12b). In a preferred embodiment, the data capture sub-unit and reactive sub-unit are combined in a singular housing and mounted on an adjustable tripod, stand, floor or fence. The remote unit can also be mobile or portable. For example, the remote unit may be worn by the athlete (50) or attached to another object such as a bicycle or automobile. Of course, it is to be appreciated that a person skilled in the art would recognise that the data capture and reactive units may be for logistical reasons separate units.

While the described embodiment of the training and testing system of the invention utilises wireless communication (such as one of the public radio frequency bands) as the chosen transmission medium this could be replaced by a hardwired system of data relaying, or an alternative wireless protocol such as microwave, infrared, GPRS or the like. All remote units can communicate with each other via a wireless or wired medium, suitably using fault tolerant technology, and are equipped with at least one programmable computing device, such as a micro-controller.

Each data capture sub-unit (12a) of the remote unit is responsible for collecting information and relaying it to the control unit (11). In one embodiment, the data units capture timing information using photobeam switches (15), known in the industry as "timing lights". Through either reflection or transmission of light, the state of the switch depends on whether the light beams are broken or not. When the beam(s) are broken by the passage of an athlete (50), a simple event signal is sent back to the control unit.

In further embodiments, the data capture sub-unit may be used to collect biosensor information such as heart rate or blood pressure, collect position information from GPS or other tracking units, or other types of sport sensor (such as an accelerometer or ergometer) (13) which may be worn by the athlete (50).

The remote unit (12) may generally consist of a microcontroller or microprocessor with a program stored in memory. Each individual remote unit has a unique identification label (ID). The ID is stored in receptor unit in a manner by which is accessible to the stored program. For example, the ID can be stored in the Read Only Memory (ROM) of the microcontroller, in EPROM or set by a dip switch.

In the case of the wireless embodiment of the system of the invention, the signal sent back to the control unit (11) is more than a simple event signal; it will also include the unique ID of the remote unit. In the preferred embodiment, the event signal sent by the remote unit (12) back to the control unit (11) would include a timestamp indicating the exact time that the beam-breaking event occurred. The time would be calculated from a real time clock running on the data unit, usually integrated with a microcontroller. The real time clock of each data unit would be synchronised by a message sent from the base unit at system start up time. In another less accurate embodiment, the time stamp information could be added to the event information by the control unit (11) when it receives the event signal.

There are several other means by which the real-time measurement of an athlete's speed of movement could be achieved, such as:

1) The use of GPS tracking or another system of signal triangulation such as sonar (Doppler tracking) or microwave tracking.
2) The use of an ID tag system for measuring the proximity of an athlete to specific transmitters.

3) The use of accelerometers for measurement of changes in speed and direction.

Turning to the reactive sub-unit (12b), it may interpret communication signals received directly from the control unit (11) or from the remote unit (12) in order to perform a function in accordance with a specific protocol. This can range from producing stimuli (18) for the athlete(s), to operating a wake/sleep mode for power saving. The reactive sub-units may also contain a display including an array of external light emitting diodes (LEDs) (16) for providing visual information to the athlete, and an annunciator such as a speaker (17) for providing auditory signals. The array of LEDs may be of any number and colour configuration, and may also be configured to produce alphanumeric signals or other symbols to add information to the visual stimuli. For example, the LED panel may flash the figure "1.23" in the colour red, to indicate that the athlete is 1.23 seconds behind the desired pace for the event. Other embodiments may include other light sources (such as Xenon strobe lights), a video display, or a holographic projection from the unit.

Concurrently with providing visual information or in the alternative, the annunciator in the unit may produce an auditory command saying, "speed up", and display the timing deficit on the visual display panel. A speaker may be used to emit signals of various tones and pulse frequency, though once may include options for voice, music or other auditory signals. For example, a high-pitched tone could be issued to signal the athlete to turn left, however this could be replaced by a voice signal saying, "left".

The control unit (11) is a computerised device that coordinates the remote units, as well as providing various other functions. The control unit may be a pocket mobile computer, a PDA, a laptop, a desktop computer, a mobile telephone or the like. In a further embodiment, the control unit includes typical computer components, such as a processing unit, display screen, memory, storage, input and output devices, communication ports, global network connectivity. Suitably, the control unit is capable of coordinating a wide range of wireless data signals and commands without losses due to interference.

Some desired features of the control unit are as follows:

- The control unit receives signals from the data capture sub-unit and sends commands to the reactive units. In one embodiment, this

transmission occurs via radio frequency, however other transmission mediums could be used, such as cables, infra-red, microwave, ultra-wideband, Bluetooth™, IEEE 802.11, or the like.

- The interaction between the control, data capture and reactive units is essentially coordinated in a field bus approach, utilising the intelligence of microcontroller technology and in-system programming.
- The control unit contains a series of transceivers for grouping remote units into "lanes" for ease of data management, with a different radio frequency for each lane. Division of data into "lanes" may also be implemented by a single frequency system with serialised data, collision prevention, acknowledgments and handshaking technology, or some other multiplexing system or via a cyclic polling protocol.
- In a preferred embodiment of the invention, the remote units generate the ID and time-stamping information. This data may also be generated by the control unit.
- The control unit may be powered with rechargeable batteries to assist in mobility. However, it is to be understood that other energy sources such as traditional power supplies and solar power may be utilised.
- The control unit may include a liquid crystal or other type of display for displaying information, such as results, or for programming purposes, such as by displaying menus or the like to enable selection of protocols or the like.
- The control unit may also include an operating system such as any variant of Linux™, Microsoft CE™ or Microsoft PocketPC™.
- The control unit may be mobile or portable. For example, the unit may be worn by the coach/trainer as they move around the field.
- The control unit may include storage for protocols, data capture or reactive information or additional processing.
- The control unit may store data in a relational database. For example, the control unit may store athlete data and training/competition protocols, past performance and training results and/or capture in progress data and reactive functions and like to enable valuable performance

calculations to assist the athlete and/or coach in assessing their performance.

- The control unit may provide storage of data and exchange of data and protocols with the off-field network via a hardwired or wireless communication link.

It is to be understood that the control unit may be connected to one or more additional computerised devices to impart additional functions to the control unit, such as providing additional storage, to assist in exchange of data, power or processing abilities of the control, or to provide an additional programmable fields to the control unit. It should be understood that the control unit may be connected to these one or more additional computerised devices through a hardwired (such as RS232, USB or the like) or wireless (such as GRPS, Bluetooth™, IEEE 802.11, IR or the like) communication link.

The sports training and testing system of the invention may include one or more additional components as described below and illustrated in FIG 2.

- One or more remote touch pads (14a) that consist of a contact pressure switch connected to a remote unit. The touch pad can be used as follows:
  - To measure reaction time during starts to identify the first movement of the athlete in response to a stimulus;
  - To act as a trigger switch during certain protocols. For example, a training drill for basketball may require the athlete to run/shuffle to a series of remote units arranged in a circle around the athlete. The athlete must run to the particular data unit, then return to the touch pad before the next data unit is activated. The athlete must complete 10 of these shuttles as quickly as possible.
  - To measure flight time in jumping activities (this function is known in the industry as a "jump mat")
- Remote starting gun (14b) for replicating track sprint starts. The gun can be used as follows:
  - In the present embodiment, the control unit or connected computation device is equipped with a microphone that is used to detect the sound of a traditional starting gun.

- In an alternative embodiment, a substitute gun is used that contains a transmitter for relaying start event to the control unit or remote units.
- The gun could be replaced by an alternative starting device if desired (e.g. a horn).
- The starting gun can also be replaced by using the reactive lights and/or the audio outputs on one or more of the remote units to provide the start signal.

- ID Tag System
  - Passive or active ID tags may be worn by the athletes for identity purposes.
  - In this embodiment, when the data capture sub-unit transmits timing and other information (e.g. heart rate), the message includes the ID of the athlete(s) in close proximity to the remote unit or the control unit.

Whilst off-field technology is not a necessary component of the sports training and testing system of the invention, it may be used as part of the system in the preferred embodiment. In the preferred embodiment of the invention illustrated in FIG. 1, the off-field network (30) may consist of a computer remote (31) from the on-field environment. The off-field network may share a bi-directional communication link (20) with the on-field network.

A simple embodiment the communication link between the on-field and off-field networks would be an off-line solution where the communication between both networks occurs before and after on-field sessions. In this case, the control unit or the associated computerised devices (12) are brought back to the off-field network (30) and connected to the off-field terminal (31). In one embodiment, such a connection would be via a serial cable connecting the two units. Another embodiment would be via a connection to the parallel port or USB port of the off-field terminal. If the control unit is a PDA then the connection to the off-field terminal may be via the usual cradle connection between PDAs and typical computers, or via one of the wireless communication options available to these devices.

The off-field network (30) may include one or more of the following components:

1) a workstation and associated software (31);

2) a central database (32) storing previously designed protocols and/or downloaded capture data and/or reactive functions; or

3) a web server (33) providing a communications link (20), such as an internet link to the on-field equipment, and the central database.

The off-field software may include a number of modules as described as follows:

PROTOCOL Editor

The protocol editor provides an easy to use software interface in accordance with modern user interface standards for designing new training and coaching protocols. The protocol editor may provide an easy to use software interface for designing new training and coaching protocols and also to enable the editing and modification of existing protocols. Previously designed protocols may be stored in the central database. By having all protocols being able to be designed in this manner, all existing protocols and a host of new protocols can be all created, edited, implemented, managed and run on the apparatus of the invention by a user such as a coach (40).

Configuration Downloader

The configuration downloader software module provides a system of downloading the required protocol details via communications link (20) to the control unit (11). The information is provided in such a form that the implementation and on-field management of the training protocol is automated from the control unit.

Database Synchroniser

The database stored in the on-field control unit (11) or associated computerised device is synchronised with relevant portions of the data in the central database (32) of the off-field network (30). After running protocol sessions,

the on-field data collected at the control unit may be uploaded to the off-field network to synchronise to the central database.

Results Analyser

The results analyser software module provides a user interface to a large range of options for displaying, graphing and analysing results from previous sessions stored in the central database (32). The results analyser also enables the printing of various charts of athlete performance. The control unit (11) may have a wireless Internet link to the off-field network (30) via the communications link (20). In this case, the communication link between the control unit and the off-field network may be made in real time, or directly before and after a protocol session without the need to physically download information to the off-field network.

In one embodiment, the control unit may use Internet TCP/IP protocol to connect to a web server (33) and consequently through the web server to the central database of the off-field network. This embodiment could use standard software techniques such as Microsoft web, SQL server synchronisation technologies, custom techniques using XML and SOAP, third party database servers like those supplied by Oracle™, Sybase™, Interbase™ or others.

In one embodiment, the web server (33) and central database (32) would be running on the same off-field network terminal (31). In other embodiments, the web server would be a dedicated web server and the central database another dedicated server.

Protocol Data

In the preferred embodiment, the protocol database may include the following data structures, metrics and type information providing a detailed characterization of each protocol.

The information stored in these data structures may relate to the set up and positioning of the on-field equipment, to the automatic management, data acquisition, and control of the reactive devices, for each protocol session.

Physical Layout Information

The physical layout of the on field equipment involves the location of the remote units and reactive devices, such as the positions of the start and finish lines and the positioning of any obstacles such as cones to be run around, jumps, tackle mats and so forth.

The layout information should include metric information as well as graphical displays in the form of digital bitmaps or computer-generated images illustrating the layout.

Examples of the various types of layout that may be included in this data structure are straight lane, tree structure, star configuration, and grids. Furthermore the physical layout data structure may allow for the creation of new custom designed layout types.

An example of some of the fields which may be contained within this data structure are as follow:

Number of Lanes

Depending on the number of on-field units and the nature of the protocol, more than one lane or concurrent instance of the protocol can be specified

Number of Athletes per Lane

Some protocols provide the possibility of having more than one athlete in the lane at the same time. The athletes may be running together (grouped) or starting at slightly different times (staged). In the staged case, the time interval between stages is an important parameter.

Protocol Route Data Structure

Given the physical layout of the on-field equipment for a certain protocol, the next important data structure concerns the route that each athlete takes over the physical layout. This structure includes the sequence of events involving, for example,

- the order of passing through gates
- the route details around and through obstacles

- the number of repetitions involved.
- the start and finish point.

This information can be used to generate the automatic data acquisition algorithm for on-field operation.

The Protocol Editor should also provide a tabular means of entering routing information for each user or system defined protocol layout.

In the preferred embodiment, the protocol editor should also provide a CAD/CAM style graphical tool for defining protocol layout and routing information.

Athlete Identification Management

In order to acquire data on individual athlete's performances for a given protocol, the identity of the athlete has to be managed. The preferred embodiment should support the following athlete identification strategies.

Manual

The athletes enter into the protocol according to a given order as determined by the ordering in the database. The ordering should be flexible, supporting order by previous performance such as bets first or best last , alphabetical or by some other user definable criteria. The order should also be capable of being overridden manually and certain athletes being capable of being marked as skipped or not present at the time.

Before the protocol starts, athletes line up in the various lanes according to the predetermined order shown by the central base unit device.

Automatic at Start

In the case where the hardware support stations with Radio Frequency Identification (RFID) proximity type identification, the athletes can enter the protocol in any order, as the proximity detector will automatically identify them.

Automatic Continuous

This is similar to the above example incorporating RFID except that the athlete's identity is continuously determined at multiple points in the protocol layout and route.

Protocol Library

After a protocol has been created using the protocol editor, the user names the protocol and stores it in a "protocol library" area of the database.

New entries can be added to the protocol library by either starting from scratch or by modifying an existing protocol and storing it under a different name.

New protocols can also be generated using the protocol editor by combining simple protocols to make compound protocols. In Sports Science terms the simple protocol describes a "station" while the compound protocol would describe a "circuit".

There are a number of applications for the sports training and testing system of the invention as described in the following examples.

Example 1

Reactive Sprinting and Agility Training

The remote unit (12) may measure performance in locomotive movement tasks, and in another embodiment wherein the athlete(s) (50) carries or wears a sensor or an array of sensors may also collect and relay such information as heart rate or other physiological information, or other such as speed and position to the control unit. The reactive sub-units (12b) work in conjunction with the data capture sub-units (12a) to provide stimuli (18) and direct athlete(s) (50) to perform certain movements. The data capture sub-units such as the touch pads (14a) in tum monitor the performance in these activities, and provide real-time feedback, or further movement commands, based on these results. The reactive and data capture sub-units may be collectively grouped into a remote unit, or may be separated in some situations to provide stimuli in locations remote from where feedback information is received.

An example of a protocol that may be utilised in the system is illustrated in FIG. 3. The illustrated scenario is for a single athlete (50) performing a reactive speed and agility training protocol. The athlete (50) is required to sprint as quickly as possible through the designated gates defined by a pair of remote units (12) to complete the drill. The athlete is required to react in one instance to a stimulus (18) generated outside their field of view, thus relying on peripheral vision and auditory perception to perform the movement change quickly. This particular protocol is set to stimulate four random direction changes. The dotted line in FIG. 3 shows the path that should be followed by the athlete in one protocol.

In a situation where the athlete is performing several repetitions of such a drill, a starting gate in the system may provide pacing information for the athlete to return to the beginning in time for the next repetition. FIG. 4 illustrates the combined use of the reaction time touch pad (14a) and multiple gates, which may be useful for training or testing for a basketball reactive agility protocol. In this application, the athlete (50) must stand on the touch pad (14a) to begin the drill. After a random time period, a randomly selected remote unit (12) signals the athlete with visual and/or auditory stimuli (18). The athlete (50) must move as quickly as possible to the relevant unit, and return to the centre touch pad. The time lag between signalling and the athlete leaving the touch pad is used to assess reaction time. The time taken to a) reach the gate, b) return to the touch pad, and c) the combined time for both movements, are recorded by the system. Once the athlete returns to the touch pad, the sequence is repeated for n number of trials.

FIG. 5 illustrates how the system of the invention may be used to perform simultaneous offensive and defensive reactive speed and agility protocols involving offensive and defensive players. In this example, the offensive player (50) is instructed to react to the light stimuli (18) of the remote units (12) to signify or represent an attacking path despite no ball being in play. The defensive players (51) cannot see the light indicated to the offensive player and must react to the offensive player's (50) movements alone. The dotted line denotes the offensive player's path. In this example, neither offensive (50) nor defensive players (51) have prior knowledge of the direction of movement that will be required. This form of training is not possible when using manual methods, as either the offensive or defensive player rather than a device produces the stimulus for the opposition.

Example 2

Group Reactive Training – Tactical Coaching Applications

A common practice in sports involving tactical patterns of play is to devise, learn and reproduce a range of tactical combinations, or "moves" for use in the competitive environment. In the prior art this aspect of coaching revolves around manual methods. Players will learn a variety of tactical moves devised by themselves and the coach, and the player then chooses whether to "run" these moves at various times in the competitive situation.

The training and testing system of the present invention adds a new dimension to this aspect of sports training. At present, moves are rehearsed at training in a predictable manner. That is, the coach will tell players which move to rehearse, and the players will complete the sequence of actions. With the present invention, the coach can now add a "reactive element" to the rehearsal of team tactical manoeuvres. Rather than running moves one at a time, the coach can devise a tactical "matrix" whereby the players must select from a group of moves as the play unfolds. That is, they must choose a move in "real-time" that best suits the activities of the opposition.

An example of this concept is shown in FIG. 6. In this scenario, the coach has indicated to players that they must choose a combination of actions that gets the ball to the desired point, while each player must also fulfil certain tactical obligations. Referring to FIG. 6, players (50) have to react to the visual cues ad-libbed from various remote units and to channel the ball as quickly as possible through the "clear" passages. The players chose the offensive "move" most effective for this passage of play.

For example, the person (50') third from the top starts with the ball, and must run as quickly as possible to the first illuminated (18) remote unit (12). The other players (50) must then align themselves to facilitate the fastest transfer of the ball to the next illuminated remote unit as quickly as possible, as indicated by the arrows, then a further remote unit may illuminate and the play goes on. As such the players may not know which first, last or in between remote units will be the next target which

This concept is not replicated in the prior art. Rather than simply rehearsing set moves and "enforcing" these tactical sequences in the competitive environment, the coach can now train players to be reactive to an artificial "opposition" and other environmental stimuli. This system therefore achieves a far superior simulation of the unpredictable sporting environment.

Example 3

Pacing and Race Feedback

The sports training and testing system of the invention may also be used to collate timing information and to provide immediate feedback to the athlete(s) on the progress of their performance. FIG. 7 illustrates the basic function of the system of the invention for athlete timing and pacing. In this example, the athlete (50) is performing a 400m-sprint protocol, though the distance may be modified depending of what is desired event to be performed by the athlete. In this scenario, a starting gun (14b) that is connected to the control unit may be used to initiate timing at the start of the event. A reaction time touch pad (14a) may detect the first movement of the athlete in response to the gun, thus allowing assessment of the athlete's reaction time.

As the athlete runs around the track, timing information is collected at N intervals depending on the number and spacing of the remote units. It will be appreciated that the data unit(s) may be flexibly configured at desired points around the track to provide the best performance feedback information to either the athlete or coach or both. The remote units then send the timing information back to the control unit for storage in a database.

If the database of the control unit, other linked computerised devices or the off-field network contains data on the "personal best" performance of ever recorded by this particular athlete, this information may be retrieved to give the athlete instantaneous feedback as to their performance as they run around the track.

In fact, the required pacing between various remote units may be calculated and displayed to provide the athlete (50) with feedback, as they proceed around the track. This enables the athlete (50) to determine at an instant whether their pace is ahead or behind of the time they are ultimately trying to run. For example,

when the athlete is running a time trial, remote units spaced around the distance the athlete is running may provide feedback at various stages whether the athlete is ahead or behind a pace that enables then to complete the distance they are running within a desired end performance.

For example, FIG. 7 depicts an athlete at the top of the track who is being instructed by the system of the invention that they are 1.3 seconds behind what would enable the personal best performance.

While in this example the athlete is paced according to their previous best performance, this pacing information may be generated by various scenarios, such as:

1) automatically "replaying" the previous trial for that athlete (default behaviour);

2) basing the pacing on the performance of another athlete – for example, data for the world record performance could be entered or recorded into the database;

3) basing the pacing on a theoretical or a manually derived performance, for example the coach or athlete may design a custom race strategy and practice this strategy using the system; or

4) basing the pacing on a percentage or absolute improvement on a previous or other performance either uniformly distributed over the event or applied to selected areas of the event. For example, the coach may want the athlete to run 2% faster over the entire event or the coach may want the athlete to run 2% faster only during a particular part of the race.

These functions are a major improvement on previously designed pacing and/or timing systems. The combination of freely configurable remote data stations providing accurate and instantaneous delivery of information to and from the control unit allows for any combination of pacing strategies and relational database functions to be used, in either a training or a competitive setting.

Multiple Athlete Concurrent Timing and Pacing

This application of the system of the invention is relevant to both training and race situations, and may be easily interfaced with a broadcasting system to

provide race information to coaches and spectators. FIG. 8 demonstrates the use of the system in a cycling application. In this particular scenario, the cyclists (50 and 51) are competing in a race where they are temporally separated by a length of the course (such as known in cycling as an "individual pursuit"). In this scenario, the interval and lap times of each cyclist as they pass each remote unit is calculated. The system in turn may produce a visual and/or audio signal at any one of the remote units to inform each of the cyclists of their relative position in the race with respect to the other cyclist.

For example and as illustrated in FIG. 8, a green signal reading "ahead 1.43" tells the cyclist (51) at the bottom of the track that they are currently leading the race by 1.43 seconds. The other cyclist (50) at the top of picture, receives a red signal indicating that they are "behind 1.43" seconds. Furthermore, a third coloured light (not illustrated) may be displayed to each rider to indicate his or her progress in relation to a goal performance (e.g. the world record for that event), or to signal that athletes with other information (e.g. "last lap").

Example 4

Multi-station Variable Pacing

The system of the invention may be utilised to pace multiple athletes in different concurrent tasks. For example, the system can be set up to run a number of various "stations", each requiring a different task to be completed within a certain timeframe. Examples of such protocols of course can be used to test the range of fitness of athletes, but is also useful in workplace fitness tests such as those used by fire fighters, the military or law enforcement. These tests require the person to be tested to perform a range of different tasks within set timeframes.

An example of such a multi-tasking test in a sporting context is shown in FIG. 9. This specific example demonstrates the Rugby Specific Circuit Test (RSCT), which was developed to imitate the physiological demands of 15 minutes of rugby union match play. The test contains a variety of stations (60 to 68) requiring different tasks to be performed. Some of these tasks are to be performed at maximal pace (such as sprints), while for other tasks a goal pace is set for each athlete to complete the station. In the example shown in FIG. 9, players are

required to complete three laps of this 8-station functional fitness test. The system of the invention can pace athletes through the various segments of the circuit, and provide real-time measurements and feedback on performance.

With specific reference to this example, the system of the invention can perform several desired functions as follows:

1) It can record and database timing information for each athlete as they perform the various tasks including running 30m sprints (60 and 67), serving (61), walking (62), running defensive arcs (64), jogging (65), tackling (66) and returning to the start (68).

2) It can signal the athlete when to begin each station after a set rest period.

3) It can provide pacing information to the athlete throughout the various stations.

4) It can provide feedback to the athlete as to whether or not they are achieving the desired performance.

In a preferred embodiment, the system of the invention may also perform the following functions:

1) It can collect and relay data from other measurement objects. For example FIG. 8 depicts a series of stations. Station 4 (63) in this scenario is a sports ergometer (GRUNT 3000), which measures speed and force data during impact activities. In such an application, a remote unit (not shown) can perform the additional function of collecting the outputs from the ergometer, and relaying this to a control unit. While this ergometer is only one example, similar information from accelerometers, biosensors or accuracy/skill monitoring devices could also be collected.

2) In the preferred embodiment involving the use of an ID tag attached to each athlete, the system of the invention could conduct multi-station protocols in a fully automated fashion. In this embodiment the respective remote unit would detect the ID of each athlete as they enter into each of the task at the respective stations.

Example 5

Grid Training/Testing Protocol

The system of the invention may be used to perform configurable "grid protocols" for the purposes of fitness training and/or assessment, team tactical drills and sport specific simulation protocols.

FIG. 10 illustrates a grid protocol for 3 athletes performing a fitness training/testing protocol. In this example, the system utilises a tri-colour lighting scheme, player X (50) is allocated the colour green (18a), player Y (51) the colour red (18b), and player Z (52) the colour blue (18c).

Upon commencement of the protocol, each athlete (50,51,52) is required to respond to the system commands by way of running to the remote unit (12) displaying their allocated colour (18a,18b,18c). When the athlete reaches the destination station, the system then activates another remote unit (12) in the athletes (50,51,52) allocated colour (18a,18b,18c), to which the athlete must then travel.

The goal for each athlete is to move as quickly as possible to each designated station, and continue to do so until a designated distance has been completed or allotted time elapsed. In this example, the system performs the following functions :

1) Instructing the direction of movement for each athlete (50,51,52) by selecting a remote unit (12) from which to display each athlete's designated colour (18a,18b,18c);
2) Measuring the time taken for the athlete (50,51,52) to travel to that said remote unit (12) in response to the light's initiation;
3) Selecting a subsequent remote unit (12) to which that athlete must next travel (either randomly or strategically), upon the athlete (50,51,52) arrival at the illuminated remote unit;
4) Recording the movement times between each remote unit of each athlete (50,51,52), logging these to report progress times, average velocity and other temporal details as the protocol progresses; and
5) Providing at the completion of the protocol (i.e. a set distance or allotted time), a summary of the performance of the athlete (50,51,52) as they

progressed through the protocol in measurements such as distance travelled, mean velocities of particular segments, or such changes in performance.

This protocol is an example of the how the system of the invention can be used to automate protocols, which train and assess the fitness of athletes in a manner, which is specific to field, court or ice sports such as football, hockey, basketball or netball. These tests are an excellent alternative to typical laboratory based assessments of fitness that are largely non-sport specific.

As previously discussed athlete, identification can be performed through the use of transponders. The capture of timing information and the like may also be provided through the transponders, or it may be provided through such devices as photobeams and reaction touch pads.

It is to be appreciated that the starting times of each athlete may be varied to accommodate them within the single grid. Furthermore each athlete may have a different starting point within the grid further increasing skill development and decision making as they need not only consider where next to proceed but they must also consider the position of their fellow athletes.

FIG. 11 illustrates a more complicated version of the grid protocol, in which team work, sport specific skills and equipment are integrated. In this example the are three teams each assigned a specific colour (18a,18b,18c)

1) Green Team – players X1(50), X2 (50')and X3(50");
2) Blue Team – players Y1(51), Y2(51') and Y3(52");
3) Red Team – players Z1(52), Z2(52') and Z3(52").

In this particular example, each team has a ball and are instructed to respond to the coloured lights (18a,18b,18c) commands of the system (as discussed above. In order for each team to complete the drill, one of the three players ([50, 50', 50"], [51, 51', 51"], [52, 52', 52"]) must run to the designated remote unit (12), while in possession of the ball. Upon reaching the designated remote units, another remote unit (12) within the "grid" is activated.

The protocol continues for a period of time, with the focus being on transferring the ball as quickly as possible and running through each designated

station in possession of the ball. This protocol thus trains many aspects of performance including fitness, decision-making, strategy and skill.

In variations of this drill, multiple teams could perform the drill concurrently, while also being opposed by a defensive team.

Automated PROTOCOL Management

The integration within the on-field and off-field networks of the invention provides at least one method for the complete automation of a wide range of fitness tests. Referring to FIG. 1, an automated protocol management system that may be utilised in the present system of the invention may contain one or more of the following functions:

1) the designing/editing of protocols off-field for use in the field, and downloading these to the on-field control unit;
2) detailed mentoring of the user through the process of setting up the equipment for executing a protocol in the field;
3) signalling the beginning and end of a protocol, and all required intermediate signals for the athlete and coach;
4) collecting data and storing it in the on-field or off-field database;
5) uploading data from the on-field control unit to the off-field network, such as database and analysis software to provide either online or offline information to the athlete or the coach;
6) producing basic reports (22) from the data in the on-field control unit and/or more detailed analysis and reports (21) from the off-field database and software;
7) Sharing of data between the on-field and off-field networks, and other networks (e.g. web based data sharing).

Other modifications to the invention may include:

8) Replacing the current measurement device (photo beams) with TAG tracking, GPS, Ultrawideband impulse radio tracking, radar (sonar tracking) or "beams" created using laser or Microwave technology.
9) Modifying the method for on-field networking suing another wireless protocol such as Bluetooth™, IEEE 802.11 or WiFi™.

10) Substituting the components for providing visual and auditory cues to the athlete. These may include using alternative light sources, video displays, LCD displays, holographic projections or virtual reality displays.

The methods, apparatus and systems of the invention have broad uses in a wide range of sports for use in training, testing, and competitive environments. The system not only has applications for using by the sporting community, but also for workplace and other function performance situations that require methodical monitoring and feedback on speed and ability of movement.

It will of course be realised that while the foregoing has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

DATED THIS #FIFTEENTH# DAY OF SEPTEMBER, 2003
FUSION SPORT PTY LTD
BY
PIZZEYS PATENT AND TRADE MARK ATTORNEYS

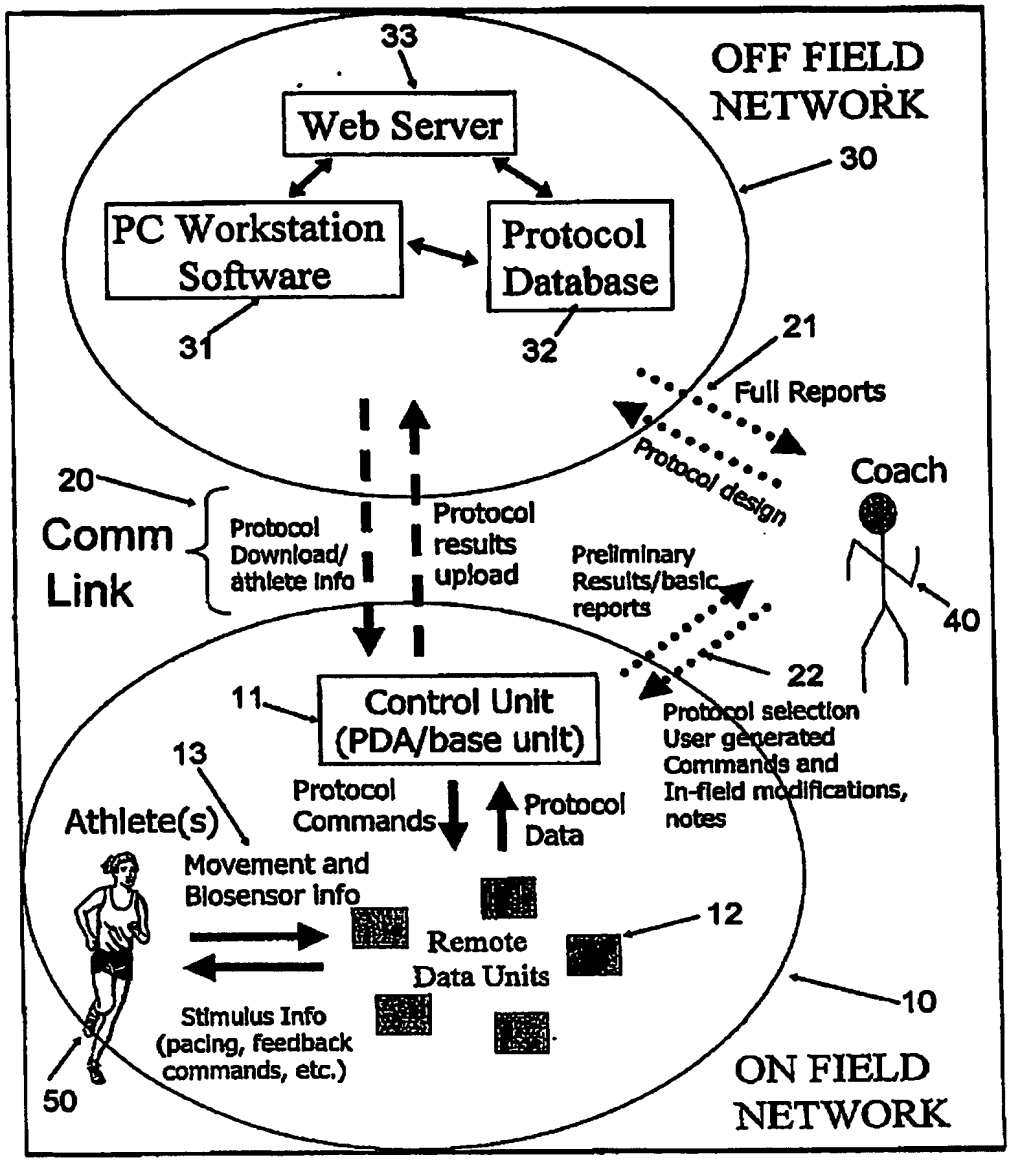
33
OFF FIELD NETWORK
Web Server
30
PC Workstation Software
Protocol Database
31
32
21
Full Reports
Protocol design
Coach
20
Comm Link
Protocol Download/ athlete info
Protocol results upload
Preliminary Results/basic reports
40
22
11
Control Unit (PDA/base unit)
Protocol selection User generated Commands and In-field modifications, notes
13
Athlete(s)
Protocol Commands
Protocol Data
Movement and Biosensor info
12
Remote Data Units
10
Stimulus Info (pacing, feedback commands, etc.)
50
ON FIELD NETWORK

FIG. 1

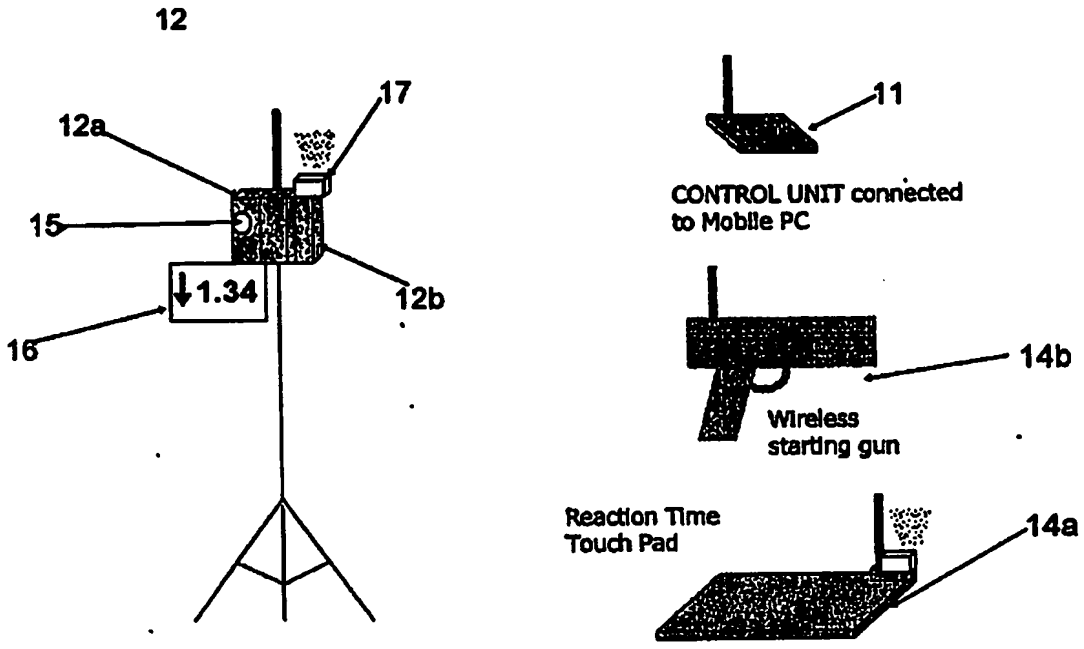
12
17
12a
15
1.34
12b
16
11
CONTROL UNIT connected
to Mobile PC
14b
Wireless
starting gun
Reaction Time
Touch Pad
14a

FIG. 2

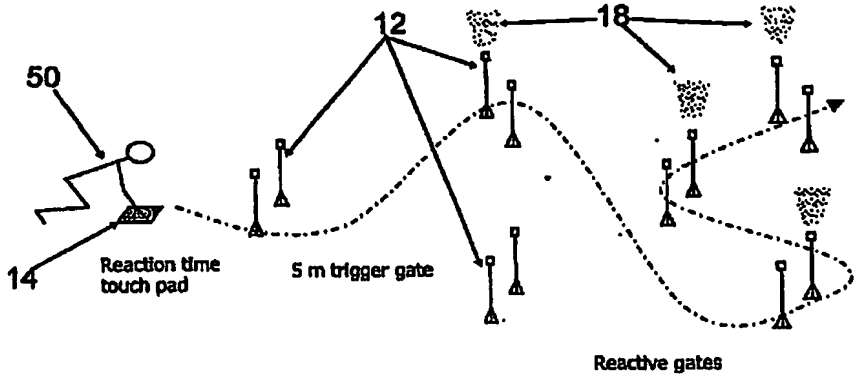
12
18
50
14
Reaction time
touch pad
5 m trigger gate
Reactive gates

FIG. 3

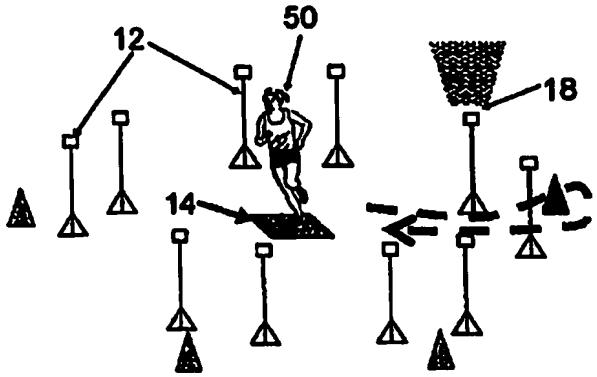
12
50
18
14

FIG. 4

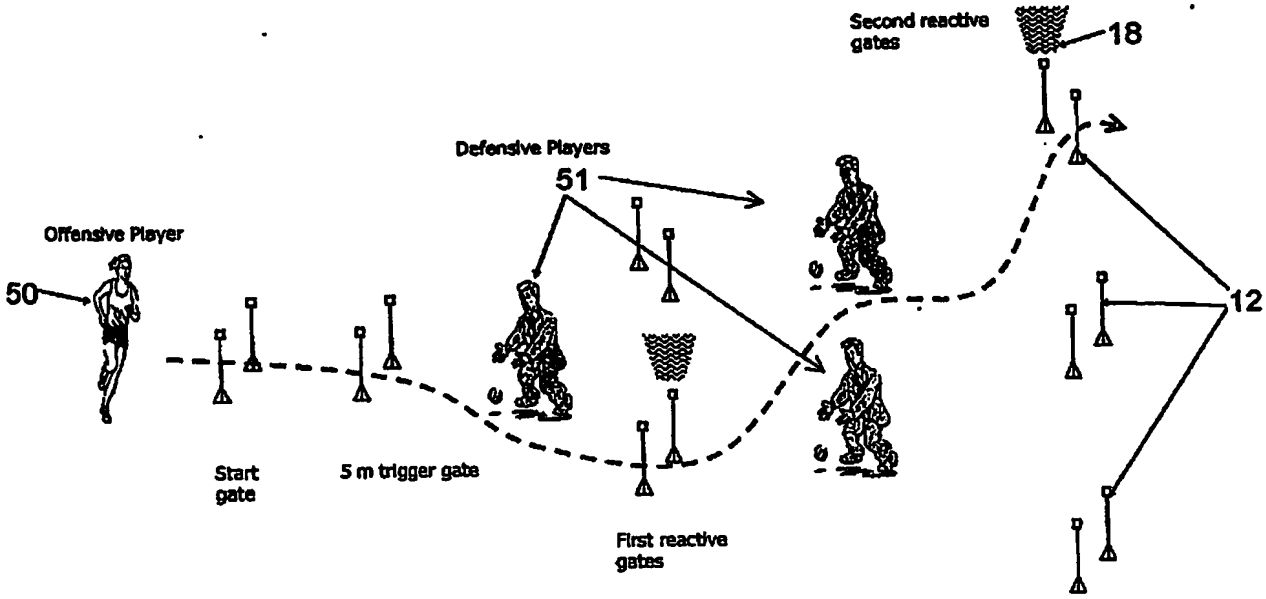
Second reactive gates
18
Defensive Players
51
Offensive Player
50
12
Start gate
5 m trigger gate
First reactive gates

FIG. 5

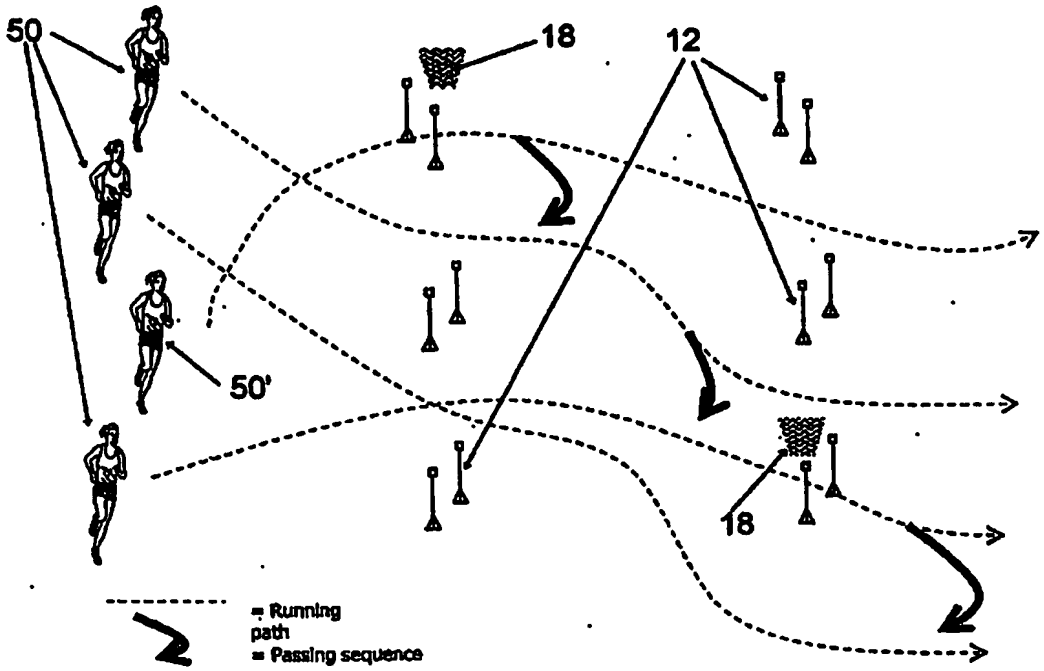
50
18
12
50'
18
= Running path
= Passing sequence

FIG. 6

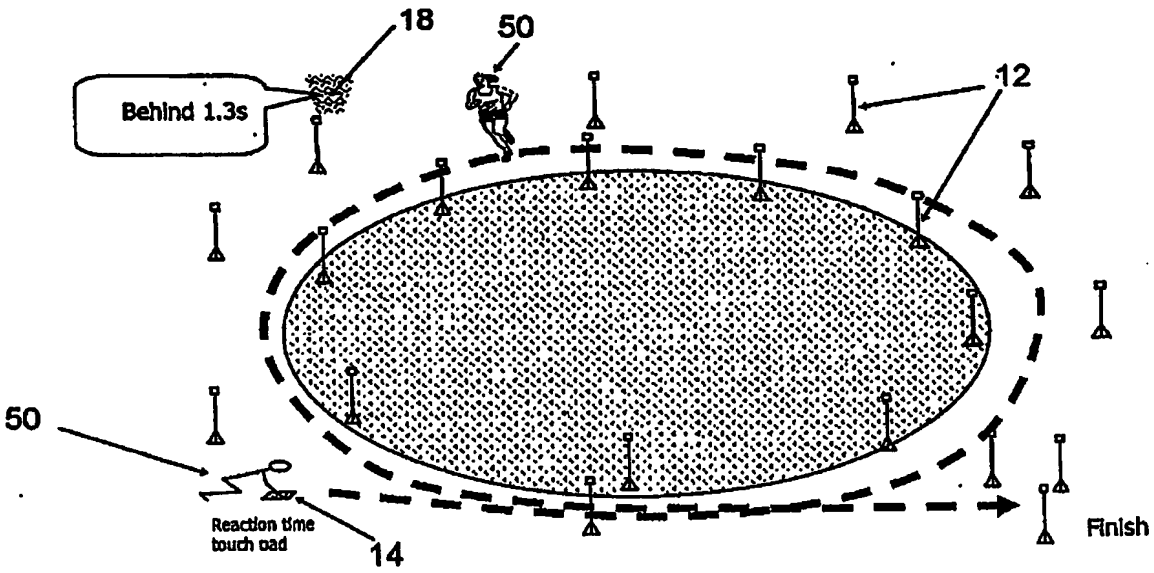
18
50
Behind 1.3s
12
50
Reaction time touch pad
14
Finish

FIG. 7

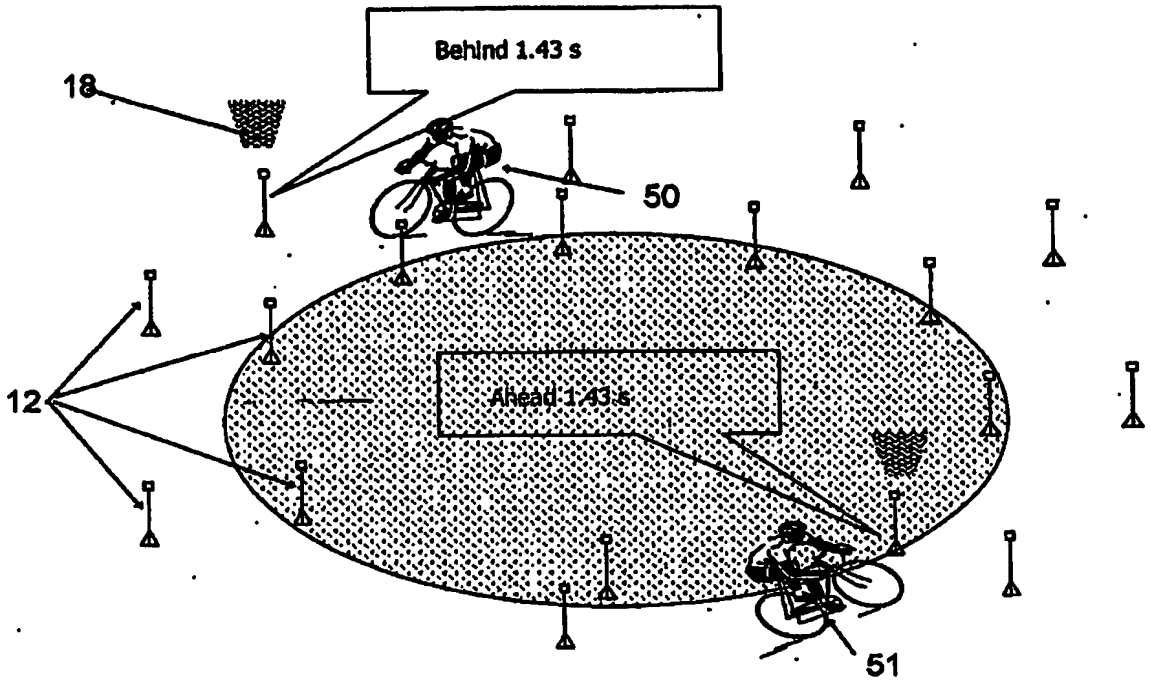

FIG. 8

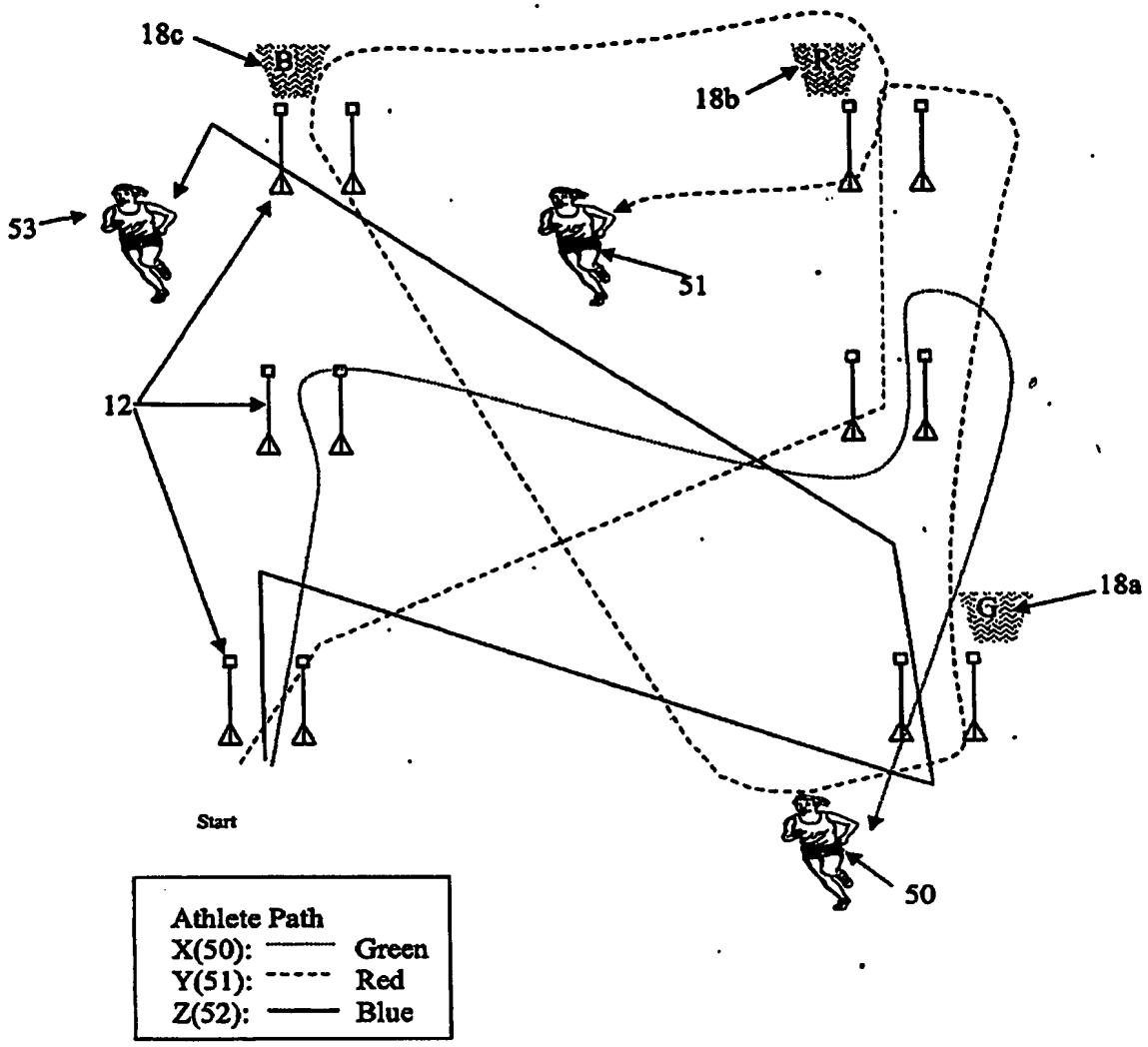
18c
B
18b
R
53
51
12
18a
G
Start
50
Athlete Path
X(50): Green
Y(51): Red
Z(52): Blue

Fig 10

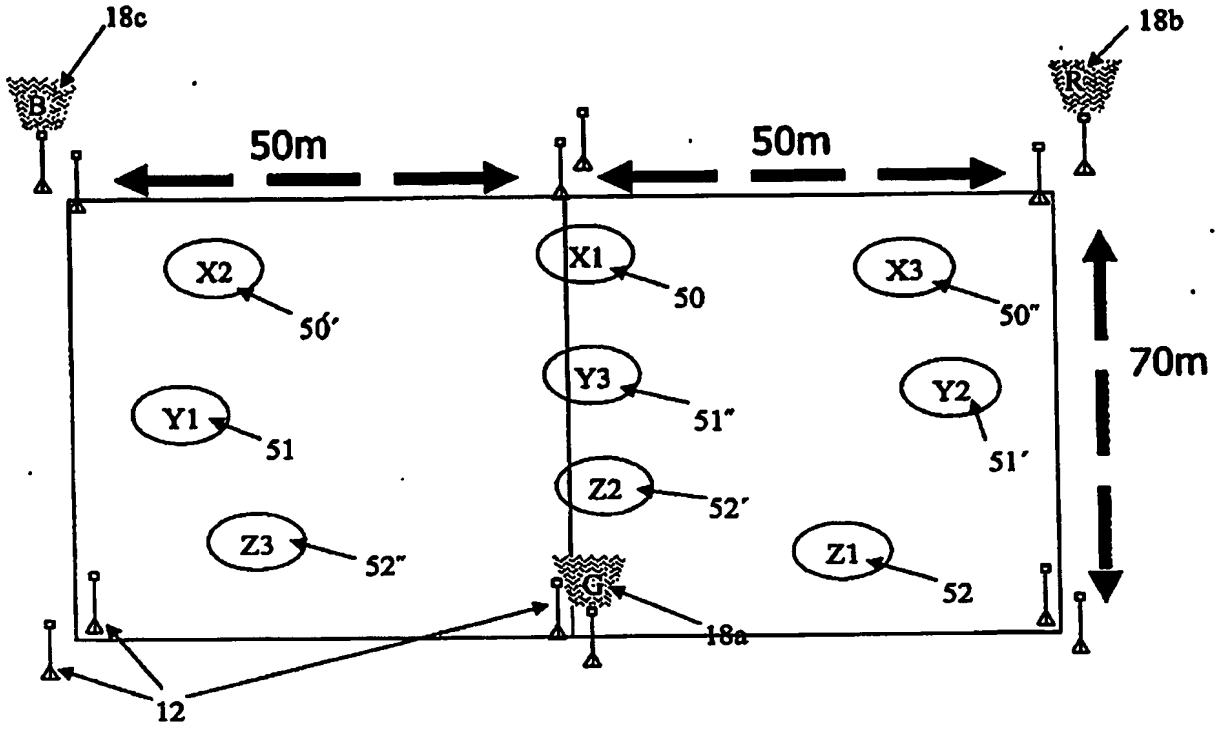
18c
18b
B
R
50m
50m
X2
50'
X1
50
X3
50"
70m
Y3
51"
Y1
51
Y2
51'
Z2
52'
Z3
52"
Z1
52
G
18a
12

Fig 11